

Article

Concept Mapping in the Age of Deleuze: Fresh Perspectives and New Challenges

Ian M. Kinchin *  and Karen Gravett 

Department of Higher Education, University of Surrey, Guildford GU2 7XH, UK; k.gravett@surrey.ac.uk

* Correspondence: i.kinchin@surrey.ac.uk

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Abstract: This conceptual paper offers a reconsideration of the application of Novakian concept mapping to higher education research by putting to work the Deleuzian concept of the rhizome. We ask: what does thinking with Deleuze's concepts offer researchers interested in concept mapping, and what conceptual, and terminological, obstacles might be created through such a reconceptualization? We have focused on the rhizomatic principles of mapping and tracing in the context of concept mapping. We contend that Deleuze offers a fresh line of flight with the potential to deterritorialise the discourse surrounding concept mapping, thus widening its applicability and increasing its accessibility to researchers who do not necessarily share the same arborescent concept mapping heritage: with its roots in science education. Exploring the overlap between rhizomatics and concept mapping also allows for the reappraisal and blurring of the boundary between structural and post-structural discourses—breaking down an unproductive binary in the literature.

Keywords: assemblage; becoming; concept map; lines of flight; rhizome; tracing

1. Introduction

Concept mapping (as a tool and as a field of study) is secure in its provenance that provides a robust theoretical underpinning. This is explicitly derived from the theoretical work of David Ausubel [1] that has been operationalized by the practical development of concept maps by Joe Novak [2]. This heritage has enabled concept mapping to be used and developed in a variety of higher education contexts as a mechanism to support the enhancement of meaningful learning [3]. Few would question the value of a clearly defined and well-documented research lineage [4,5], and it is not our intention to review that literature here. Being firmly rooted in such a robust theoretical framework has helped concept mapping to become a respected tool to enhance education, and an avenue of research in its own right. However, in moving the field forward, we are suggesting that the application of concept mapping and the theoretical consideration of learning that it inspires could be enhanced by widening the scope of educational theory with which concept mappers are engaged. Indeed, by grappling with a novel theoretical framework against which to evaluate concept mapping, it may actually strengthen the field and also entice new researchers to the concept mapping community by revealing new opportunities. In particular, we are suggesting that an application of the Deleuzian concepts of 'assemblage', 'becoming', 'rhizome' and 'lines of flight' might offer a fresh perspective on the body of concept mapping research and present exciting new challenges with which to engage. In Deleuzian terms, the rational, linear and 'arborescent' [6] nature of the development of the concept mapping field from its roots (provided by Ausubel) may now be perceived as a 'hegemonic cultural model' [7], so ingrained that it is synonymous with good and common sense [8]. However, it is clear that good and common sense (or even research evidence) are not sufficient for the wholesale adoption of teaching approaches that have been demonstrated to promote meaningful learning [9].

This is because ‘rational, linear logical and common-sense narratives are too narrow to attend to the complexity of human and social phenomena’ [10]. This has been summarised nicely by Snir [11]:

The problem for Deleuze lies in the imperialism of common sense, in the way it takes over thought and action, casting them in conformist patterns . . . even when trying to be critical, common sense thought in fact reaffirms and reproduces the prevailing political order and the meanings it assigns to subjects and objects. (p. 302).

So, whereas linearity maintains the status quo, the rhizome encourages the destabilising examination of difference. The image of the rhizome has not yet led to extensive cartographic analysis of knowledge despite, what appears to us, as obvious overlaps as described by Ruitenberg [12]:

Because of their multiple connections, rhizomatic knowledge structures are difficult to represent in traditional, more linear text. Cartographically, however these multiple connections can both be represented and questioned. When one attempts to map rhizomatic processes or texts, one may discover other nodes and connections not previously realized. (pp. 17–18).

Therefore, we anticipate that an exploration of this overlap will widen, deterritorialize and develop the (currently) separate discourses of concept mapping and rhizomatics.

2. Approaching the Rhizome

Rhizomatics is a mode of thinking that disrupts the more traditional, hegemonic, linear approach that traditionally dominates Higher Education. Instead of a forced unity (described as arborescent or tree-like—[13]), the rhizome is a messy, de-centred, network that grows horizontally in all directions. The non-linear growth of the rhizome encourages the development of links to other networks and so exhibits a greater level of knowledge recipience—the ability to actively make connections to form new understandings [14]. Initial reading of Deleuze and Guattari’s work exploring the rhizome immediately suggests overlaps between rhizomatic thinking and concept mapping. For example, the versatility and malleability of concept maps resonates with Deleuze and Guattari’s [6] description of the rhizome:

The map is open and connectable in all of its dimensions: it is detachable, reversible, susceptible to constant modification. It can be reworked by an individual, group or social formation. (p. 12).

This is reinforced by Tillmanns et al. [15] who describe how ‘the rhizome has the potential to inspire educators and learners alike to become more critically aware of the interconnectivity’ within the curriculum. However, much of the terminology used by Deleuze and Guattari makes access to their ideas quite demanding. We found our own entry into the literature inspired by Deleuze and Guattari [6] a difficult journey. Like Strom [16] we found the work of these two theorists to be ‘like a foreign language, and the concepts required that [we] stretch [our] thinking in entirely new and uncomfortable directions’. However, this is largely the point. Through this discomfiting encounter with a new ‘language’, Deleuze and Guattari deliberately ‘stretch’ our thinking. St Pierre, in interview with Guttorm, Hohti, and Paakkari [17] explains the impact that new terminology can have upon our understanding:

One of the things that happen when you begin to read post-structural theories . . . is that the old words don’t work anymore . . . Derrida wrote that when you use a concept you bring with it the entire structure in which it is thinkable . . . What is particularly helpful in Deleuze and Guattari’s work is that they have given us lots of new concepts that are not embedded in humanist epistemologies and ontologies. (pp. 15–16).

As St Pierre explains, Deleuze and Guattari's work gifts the reader with new concepts that can enable us to think differently. Moreover, Deleuze and Guattari give their readers licence to take what connects with you and that you can use at that moment. It is these new concepts and new directions that we now apply to the field of concept mapping.

The application of a Deleuzian lens to the historical development of concept map analysis shows how concept mapping research has been edging towards some principles of Deleuzian philosophy without realising it. Or to paraphrase Rorty [18], Deleuze seems to have been waiting at the end of the road along which concept mapping is currently travelling. For example, much of the early work (and some of the more recent work too) that has employed concept mapping as a research tool has drawn upon its science education roots in quantitative methodology [19], to convert concept maps into scores to facilitate statistical analyses on student development. Scoring is particularly favoured in disciplinary areas that have traditionally favoured quantitative research methods [20–22]. However, this reduction of the rich data of a concept map to a simple metric does not sit well with many researchers—even with the originators of the tool. Novak and Gowin [23] were not convinced of the value of such scores themselves, stating that 'scoring was in many respects irrelevant, for we were looking for qualitative changes in the structure of children's concept maps'. White and Gunstone [24], not only doubt the value of such scores, but also caution against the damaging effects of scoring, stating: 'giving any form of grade to a map can alter students' attitudes to them and so threaten their potential to promote learning.' However, many research papers have scored concept maps based on a variety of scoring protocols, most of which involve analysing maps at the level of the individual proposition (concept—linking phrase—concept) for accuracy and relevance. Not only do these scoring protocols miss the point of looking for qualitative changes in understanding, but they also lose sight of the big picture generated by the map and the wider context in which it is situated. More recently, there has been increasing interest in considering maps from a more holistic standpoint, and considering their morphology [25–27], with movements between structures seen as indicative of changes in knowledge [28] and the development of expertise [29]. This qualitative assessment of maps looks at changes in concepts and relationships between them and resonates with Rajchman's [30] explanation of travel through the rhizome:

... there are different conceptual 'bits', each initially introduced in relation to a particular problem, then reintroduced into new contexts, seen from new perspectives. The coherence among the various bits shifts from one work to the next as new concepts are added, fresh problems addressed; it is not given by 'logical consistency' among propositions, but rather by the 'series' or 'plateaus' into which the conceptual pieces enter or settle along the web of their interrelations. (p. 21).

3. Navigating the Overlap

In attempting to find common ground between the literature on concept mapping and the literature on rhizomatics, there is potential for constructing an unhelpful tension between the terminology used to describe a tool (concept mapping) that is explicit in its application of illustrating structures of complex phenomena [31], and a philosophical interpretation of knowing that is often aligned to a post-structuralist view of the world [6]. When referring to the artefacts of learning, Novakian maps can be understood as Deleuzian tracings. Whereas within the process of learning, Deleuzian mapping and Ausubelian meaningful learning are synonymous activities of active exploration and discovery. By adopting a Deleuzian (or Deleuzo-Guattarian) lens, it is not our intention here to develop a line of thought that might actually exclude anyone from applying concept mapping in any way they want to. We are not attempting to develop a perspective to constrict or inhibit thinking—such an exclusionary mechanism would itself be anti-Deleuzian by preserving high theory for the use of a select few [16]. One way of helping colleagues to recognise the relationship between concept mapping and rhizomatic cartography here is to use the language of the rhizome within the grammar of a concept map (Figure 1).

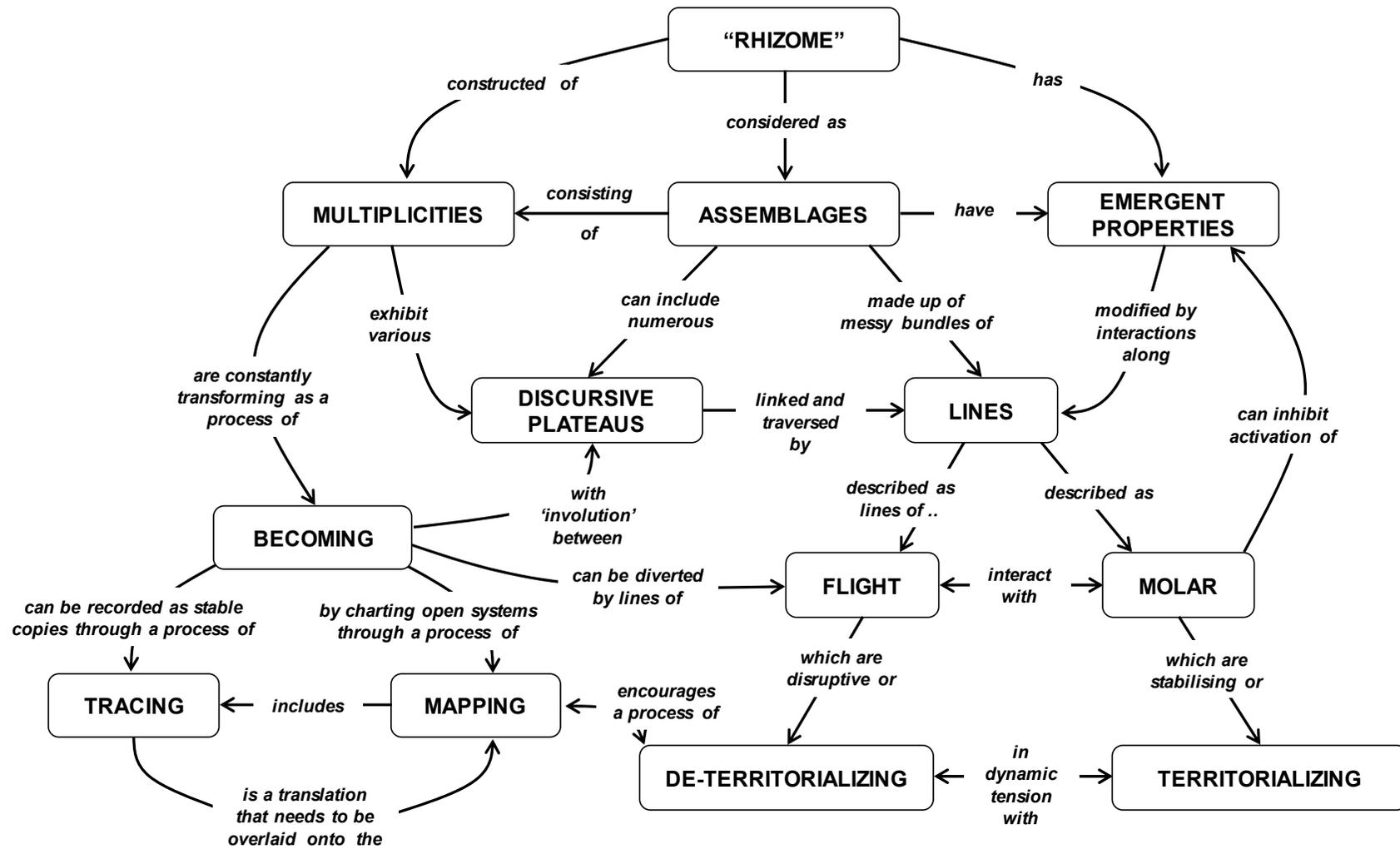


Figure 1. Putting together the language of the rhizome using the grammar of a concept map.

In our summary of Deleuzian terminology offered in Figure 1, we acknowledge that this is certainly not comprehensive in its coverage. This is Deleuzian in its approach as ‘any cartographic account is necessarily selective, partial and never exhaustive’ [32]. We have selected key terms that we feel are necessary here to help the reader to gain entry to the language of the rhizome whilst also making our points about concept mapping. In doing so we have, like other authors before us [33], followed our ‘own particular lines of flight through [Deleuze and Guattari’s] texts, and these paths have taken us in directions that may not be taken by others’, and like others we have been ‘strategic with the language that we draw from Deleuze’s [34].

Figure 1 highlights key terms and their relations to help interpret this tracing of the rhizome. An assemblage is seen as a conglomeration of numerous, heterogeneous parts that are neither uniform in scale nor similar in nature. It includes physical parts (people, places, objects) and non-physical parts (actions, theories, emotions). The assemblage actively links these parts together by establishing relations between them [35]. An assemblage’s only unity is that of co-functioning. Rather than regarding elements of an assemblage as having static properties, (i.e., ‘being’), the rhizomatic frame considers transformations-in-action (‘becomings’), which emphasise process over product. The concept of ‘becoming’ (whose meaning in the map in Figure 2 is suggested by the constant interactions with ‘mapping’ and ‘tracing’) is a central Deleuzian concept—crucially, ‘becoming is the final reality’ [36]. Becoming is not a momentary transition from A to B, but occupies ‘the role that being used to play’. These transformations occur along ‘lines’ that move and grow through the rhizome. As the lines are constantly moving and developing, any static representation of the rhizome is transitory as the rhizome is on its way to becoming something else. Deleuzian ‘becoming’ is broadly composed of two kinds of vectors or lines of force. These are described as molar lines of articulation, which are ‘centripetal, homogenizing, hierarchizing and normalizing discourses and practices. They perpetuate the status quo’, and lines of flight that are ‘centrifugal, decentring, dispersing discourses and practices. They are the available means of escape from forces of repression.’ [37].

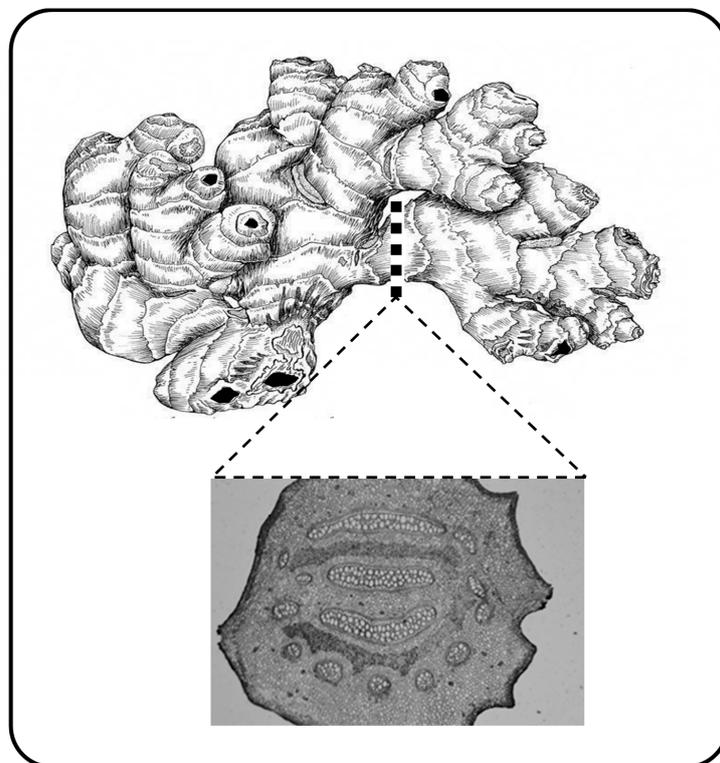


Figure 2. The gross morphology of a rhizome exhibiting an apparent lack of structure or organization with (inset) a photomicrograph of a cross section of a rhizome to show the evident structural organization at the vascular level (Photomicrograph of vascular tissue in a section of fern rhizome, by Ian M. Kinchin).

4. Mapping or Tracing?

A concept map is always ‘provisional’ and open to a multiplicity of interpretations. This has not always been made explicit in the literature, especially when the application of scoring protocols reinforces the idea of the map representing a fixed reality. Rather, we adopt the view, as described by Wilson et al [38], that:

Concept mapping is a medium through which people come to understand more about an event and about themselves. This change of self, re-shapes the meaning of the phenomenon that is being studied, and offers the participants an opportunity to “re-see” the significance the experience and the mapping process offer them. Through this process of “re-seeing,” participants develop an artistic expression of self-discovery (the concept map). (p. 1154)

This understanding of the multiple potential realities of the concept map is again enriched by adopting a rhizomatic perspective. As Lenz Taguchi [39] contends:

A process of cartography [is] preoccupied with both tracing and mapping by laying out the lines (both the [molar] articulating lines and lines of flight) . . . forming a complex rhizome. (p. 42)

It is the exploration of the deterritorializing flows and possible ‘lines of flight’, according to which the rhizome can transform and expand, that is key to Deleuzo-Guattarian rhizomatics and mapping. (p. 45)

Exploration of the lines within the rhizome offers an insight into the nature of the wider assemblage, to help make sense of the complex environment in which (in this case) teachers in higher education are required to enact their professional activities:

Mapping lines of articulation and lines of flight thus makes visible the multiplicity and creative potentials inherent in any organization of reality. Ultimately, mapping discloses potential organizations of reality rather than reproducing some prior organization of it. [37]. (p. 671)

As the map under construction is a moving construction of converging and diverging lines and their connected practices, we need to acknowledge that a Deleuzian (or Deleuzo-Guattarian)-inspired cartographic exercise is not about representing a final structure, but rather it is about constructing a map as a field of play to experiment on [39]. That is, the process of mapping is more important than production of the artefact—the tracing (Figure 2).

5. Rhizomatic Analysis of Contestations in the Concept Mapping Literature

Much of the literature on concept mapping, particularly in science education, has been rather uncontroversial—adding incrementally to the arborescent knowledge structure of the discipline. However, the paper by Karpicke and Blunt [40] generated some debate and disagreement within the academic community—an exchange that may have proceeded differently if viewed through a rhizomatic lens. The study by Karpicke and Blunt was conducted under laboratory test conditions and was set up to compare the quantity of learning among groups in a student body supported by either testing (retrieval practices) or concept mapping (elaborative learning). This was a scientifically rigorous, experimental paper, published in a prestigious journal. As such, a number of later authors subsequently aligned their papers with this viewpoint [41].

However, a number of academics felt that assumptions made by Karpicke and Blunt were at odds with those widely accepted by the concept mapping research community, and chose to publish a critical comment on the original paper, citing various issues that they considered to undermine the authors’ findings [42]. These included several procedural concerns about the nature and duration of the training

that the students had received in using the concept mapping tool; the laboratory style nature of the environment in which the work was undertaken and its relevance to authentic classroom environments; the inadequacy of the time frame of the study to assess meaningful learning and the artificial separation of classroom tools (i.e., retrieval vs. concept mapping) when typically classroom teachers would weave between various teaching tools in their repertoire. While these are relevant criticisms of the original paper, unfortunately critics [42] were restricted in their critique by the arborescent knowledge structure in which they were working—dominated by science education. This allowed Karpicke and Blunt [43] to offer an immediate repost to these criticisms. In addressing the critique [42], Karpicke and Blunt [43] made further questionable assertions made from a rather partial reading of the literature. In stating that the literature claimed that a few minutes was sufficient for students to be able to use concept mapping, they failed to acknowledge that using concept mapping as a classroom tool is not the same as producing high quality maps that can be used in research. The crucial issues of map purpose and map quality [44] were not discussed. The authors' emphasis on the lack of Randomized Control Trials (RCTs) in the literature to demonstrate that extensive training of concept maps is necessary, reveals a bias in the authors' conception of 'quality research'—favouring quantitative data over qualitative analysis. Such a methodological approach can inappropriately privilege the research agenda over practitioner experience and has been linked to a discriminatory research ideology rather than reasoned approach to addressing a research question [45]. Karpicke and Blunt go on to argue that familiarity with a technique (such as concept mapping) is not related to effectiveness, but this seems to be missing the point of the teacher in the classroom and the importance of dialogue and feedback to stimulate higher order thinking. Those who have used concept mapping extensively in their classrooms will know that (whilst the tool can be acquired quickly) mastery of concept mapping and the drawing of high quality maps takes time and practice, supported by feedback and editing of maps to enhance their explanatory power [46,47]. While there were no examples of student concept maps offered by Karpicke and Blunt [40] that would allow the reader to gauge the quality of the data being considered, a subsequent paper by these authors [48] offered an example of a 'retrieval-based concept map'. This example was quite linear in its structure, with no cross-linking of concepts and featuring generic linking phrases (e.g., 'leads to', 'transferred to', 'called') that do little to add explanatory power to the map. Such a map is likely to 'require students to adopt an ineffective retrieval strategy' [48], and will fail to address the Deleuzian imperative that 'the essential thing about a diagram is that it is made in order for something to emerge from it' [49].

The importance of providing feedback on students' maps is emphasised by Morse and Jutras [50] who concluded that 'concept maps without feedback have no significant effect on student performance, whereas concept maps with feedback produced a measurable increase in student problem-solving performance and a decrease in failure rates' (p. 234). Joseph et al. [47] have shown that the application of structured feedback (supported by review of lecture notes and dialogue with peers) can help students to increase the sophistication of their maps—particularly moving from simple spoke or chain structures towards more complex net structures [26]. This is consistent with the wider literature on the positive impact of appropriate feedback to improve student learning in Higher Education [51].

The arborescent viewpoint that simply more research, especially controlled experiments and RCTs, should be conducted to add to the body of knowledge rather than different research, emphasises the disconnect in the authors' minds about the concept mapping tool and the messiness of the wider teaching assemblage [52]—insistence on the experimental control of variables resulting in the avoidance of the emergence of any disruptive lines of flight. In consequence, taking the students' initial concept maps as the definitive (snapshot) data source, they are also emphasising the immediacy of 'being' and ignoring the students' acts of 'becoming'. In the absence of feedback and dialogue with teachers and peers, the students were being denied any further becoming and so the data, taken at an arbitrary time frame of one week, will favour some students and penalise others—especially those students who were trying to learn meaningfully (for understanding) rather than superficially (for testing). A rhizomatic critique of the study by Karpicke and Blunt [40] offers a much wider canvass for analysis, and by

taking the critique outside the authors' original frame of reference, it offers a more insightful analysis of its weaknesses. Some of these fundamental criticisms that relate to the structure of knowledge and its representation could have been offered by Mintzes et al. [42] if they had not been operating within the restrictions created by adopting the same arborescent frame as Karpicke and Blunt [40].

6. Concept Maps and Slices through the Rhizome

It is clear that we could be setting up a potential tension in this work by aligning the post-structuralist notion of the rhizome, with the concept mapping tool that has been explicitly linked to the structural representation of knowledge [31]. This would be the case if we suggested that there was a mapping/tracing duality, with one superior to the other. However, Deleuze and Guattari do not adopt such binary conceptualisations and neither do we. Rather, we are interested in the generative possibilities of a blurring of the boundaries between these two ostensibly opposed perspectives. In his analysis of Deleuzian theory, Harris [53] brings us back to the ways in which we can produce concrete visualisations of assemblages, and considers the use of concept maps, noting that:

The intriguing possibility arises that those concept maps can themselves be seen as figures cut from or sliced through a more complex rhizomatic multiplicity as a cross section. (p. 230).

Whilst authors are happy to emphasise that the rhizome has no structure, we wish to problematise this by saying that the rhizome has no discernible structure in terms of its gross morphology. However, if we look at a biological rhizome (that provided the original inspiration for Deleuze and Guattari), we have to say that the perception of structure depends on the level of resolution and on the instruments used to make observations. The photomicrograph of a biological rhizome (inset to Figure 2), shows clearly that, at the microscopic level, the rhizome exhibits an obvious structure when viewed in cross section. There are evidently tissues that are explicit representations of a sense of order among the cells.

By analogy, the concept map may therefore be considered as a view of a section of the rhizome at the 'vascular level' [54,55]. We may also acknowledge that, in Deleuzian terms, this representation may be considered as a tracing of the rhizome - the microscope slide has been fixed and stained to provide a static representation of the internal structure (Figure 2). This structure will change over time. Cells will divide and multiply and tissues will mature. Materials may be deposited and incursions by pathogens or herbivores will impact upon the structures observed. But static representations such as that offered in Figure 1 are still of value to the biologist trying to ascertain the workings of the biological rhizome. Similarly, concept maps are of value in determining the workings of the conceptual rhizome by offering an imperfect window into its workings.

In juxtaposing Novakian concept mapping with Deleuzian philosophy, we have blurred the boundary between structural and post-structural analytic approaches, and draw on the perspective articulated by Massey [56], that 'what post-structuralism has most importantly achieved is the dynamization and dislocation of structuralism's structures'. It is therefore appropriate here to extend the figuration (analogy) of the rhizome. Analysis of the complex architecture of botanical rhizomes has revealed that the apparent lack of structure (in relation to arborescent plants) only holds at a superficial level. Detailed analysis shows a highly differentiated network of vascular tissue [54,55] providing a direct analogy for Deleuze's 'lines'. This resonates with comments by Koro-Ljungberg [57] and her work reconceptualising qualitative research, when she refers to the value of 'a structure in its "un-structuredness"'. I do not refer to randomness but to a structure that works against structure'. This further exploration of the potential of rhizome anatomy is not to impose a structure on a system (for purposes of managerial control), but to appreciate the complexity of the system for what it is.

One of the central tenets of rhizomatics is that every point of the rhizome has potential connections with every other part. Within the concept map, again every node in the map is potentially connected to every other node. However, we choose to highlight key connections and ignore others to avoid overloading the concept map with links and making the map illegible. In Deleuzian terms, the essential

thing about the diagram is that it is made for something to emerge from it. If nothing emerges (such as enhanced clarity of understanding), ‘then it fails’ [58].

Does this then mean that a student’s concept map of accepted and agreed curriculum knowledge (complete with errors and omissions) fails as a diagram? We would contend that it depends what is then done with that map. Deleuze and Guattari are clear that the tracing always has to be laid back on the map. In practical terms, this means that the student has to reflect on the concept map and overlay it back on his/her developing understanding—something that was not done by Karpicke and Blunt [40]. This is where the teacher has a role in supporting this overlaying—guiding the students and offering feedback so that the teacher’s understanding interacts with the students’. The student map that is full of errors will be adding to the teacher’s understanding of their students’ learning, and also of the effectiveness of their teaching strategy. The ‘success’ of the map, therefore, lies at the hands of those involved. Though articulated using different terminology, this is already known in the concept mapping literature. Concept maps have limited utility if they are not the focus of dialogue—often formulated as feedback [47]. Concept maps do not operate in isolation to enhance learning, but contribute as an integrated component of the teaching assemblage.

7. Conclusions

Continued adherence to a single supporting theory, grounded in the linear logic of science education, has impeded the development of concept mapping. By providing secure roots, (Ausubel’s theoretical work), the concept mapping literature has taken an arborescent knowledge structure [6], from which the routes for novel insights are limited. The adoption of a rhizomatic lens offers a fresh perspective that suggests new lines of flight and alternative avenues for research. In advocating such a rethinking, we offer an alternative lens, an ‘irruption’ that questions ‘linearity and normativity embedded in current research practices and “knowing”.’ [57]. In many ways, research using concept maps has been calling for such an alternative lens to help articulate some of the issues surrounding the field and inhibiting its potential for growth. A recognition of the problems of linearity and simple binaries that have been addressed in the concept mapping literature echo the considerations of Deleuze’s theoretical works. However, there are challenges for the concept mapping community in departing from such neo-positivist and interpretative frameworks, towards what could be considered a more post-structuralist and post-qualitative epistemological approach. The theoretical stance offered by rhizomatics with its emphasis on ‘becoming’ rather than ‘being’ is provocative, and the unfamiliar terminology that surrounds such a rethinking may be challenging for many readers and researchers. There are also issues of analysis—where we are looking for similarities or alignment to a model/expert answer or where we are explicit in our exploration of the ‘yet-to-be-known’ and the illustration of difference: the latter being more Deleuzian than the former. In part, the literature has already offered responses to some of these challenges. The distinction is often made between the application of concept mapping (as a process of exploration and learning) and the application of concept maps (as artefacts or records of prior learning). The exploratory process of concept mapping resonates with the Deleuzian concept of mapping, whereas the analysis of static maps bears more resemblance to the consideration of Deleuzian ‘tracings’. Following Koro-Ljungberg, we suggest that irruptions may ‘serve as examples of uncertainty and “unthinkable” energy’ [57]. Within this article, we have instead attempted to explore what might be the outcome of thinking with Deleuze to reconsider some of the conceptual blockages and certainties surrounding concept mapping, and we argue for the potential scope for new directions, challenges and questions within this rich field of research.

Rather than simply glossing over the idea of the rhizome as a novel way of looking at knowledge and the way in which it is structured, a detailed analysis of the botanical rhizome offers potential for extending the analogy and providing new ways to conceptualise the role of the concept map. Whether we are looking at the arrangement of the internal tissues of the rhizome [54,55] or the complexity of the branching patterns and the ways in which that might adapt to different environmental conditions [59,60],

there is potential to consider concept maps as figures cut from the rhizome [53] that offers a very different perspective on their role in promoting meaningful learning.

8. Practical Implications

Following on from these conclusions, there are a number of practical implications to consider. For those colleagues who would like to apply a Deleuzian lens to the application of concept mapping in the future and become rhizomatic researchers [61], we would suggest a few guiding principles that require some deliberation by researchers at the outset of their projects. A consideration of the impact on the research participant as the focus of the research (rather than the content being mapped) and his/her movement within the developing rhizomatic assemblage requires a shift in emphasis from 'being' to 'becoming'. As such the scoring of individual maps is counter-productive as it creates an arbitrary end point for the student/participant and may close down further learning. Maps should therefore be seen as gateways into future learning rather than representations of prior learning. This requires the researchers to consider how maps are opening up new avenues of learning. This might be achieved through the application of serial concept mapping studies in which the development of concepts is investigated. Serial concept mapping (e.g., [62]) is an approach to construct progressive knowledge frameworks, and has great potential that has not yet been realised widely in the literature, and has not been considered at all in terms of rhizomatic analysis.

Studies that focus on the student (rather than on content) might look at the way in which learner-transformation might be manifest. For example, if concept mapping interventions are used in Chemistry lessons, then students who have internalised the principles underpinning concept mapping (e.g., meaningful learning) might be expected to adopt enhanced learning strategies in other curriculum areas. We might expect to see students developing new strategies in, for example, their Physics lessons—particularly if the teaching in Physics is designed to invite these learning strategies. Such studies of student spill-over strategies are currently missing in the concept mapping literature.

As concept mapping would be just one element within a student's developing rhizome of knowledge, studies that try to isolate the effect of one learning tool against another, such as that attempted by Karpicke and Blunt [40], would be inappropriate and fail to grasp the interrelatedness of different lines within the rhizome. Rather than bracketing out other variables and excluding contextual factors that may influence learning, the rhizomatic concept mapper needs to embrace the messiness of the teaching assemblage [52].

We realize that what we are proposing here will complicate the lives of researchers who are intent on exploring the utility of concept mapping from an Ausubelian perspective. However, we should state that Deleuze and Guattari [6] were clear that the 'root-tree' and the 'canal-rhizome' are not two opposing models. As explained by Grigoriou [63], 'it is not a matter of exposing the Root and announcing the Rhizome. There are knots of arborescence in rhizomes and rhizomatic offshoots in roots'. Deleuzian ideas were not intended to overturn everything and we should, as often suggested by Deleuze, take what works for us and 'construct a feasible zone of innovation' [64]. It is therefore fine to experiment with Deleuzian ideas, and modify research approaches by taking what works in a particular context.

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References

1. Ausubel, D.P. *The Acquisition and Retention of Knowledge: A Cognitive View*; Springer: Dordrecht, The Netherlands, 2000.

2. Novak, J.D. *Learning, Creating and Using Knowledge: Concept Maps as Facilitative Tools in Schools and Corporations*, 2nd ed.; Routledge: Oxford, UK, 2010.
3. Hay, D.B.; Kinchin, I.M.; Lygo-Baker, S. Making learning visible: The role of concept mapping in higher education. *Stud. High. Educ.* **2008**, *33*, 295–311. [\[CrossRef\]](#)
4. Novak, J.D.; Cañas, A.J. The origins of concept maps and the continuing evolution of the tool. *Inf. Vis. J.* **2006**, *5*, 175–184. [\[CrossRef\]](#)
5. Novak, J.D.; Cañas, A.J. Theoretical origins of concept maps, how to construct them, and uses in education. *Reflect. Educ.* **2007**, *3*, 29–42.
6. Deleuze, G.; Guattari, F. *A Thousand Plateaus*; Massumi, B., Translator; Bloomsbury: London, UK, 1987.
7. Braidotti, R. *The Posthuman*; Polity Press: Cambridge, UK, 2013.
8. Deleuze, G. *Logic of Sense*; Bloomsbury: New York, NY, USA, 1994.
9. Kinchin, I.M. If concept mapping is so helpful to learning biology, why aren't we all doing it? *Int. J. Sci. Educ.* **2001**, *23*, 1257–1269. [\[CrossRef\]](#)
10. Strom, K.J.; Martin, A.D. Thinking with theory in an era of Trump. *Issues Teach. Educ.* **2017**, *26*, 3–22.
11. Snir, I. Making sense in education: Deleuze on thinking against common sense. *Educ. Philos. Theory* **2018**, *50*, 299–311. [\[CrossRef\]](#)
12. Ruitenberg, C.W. Here be dragons: Exploring cartography in educational theory and research. *Complicity An. Int. J. Complex. Educ.* **2007**, *4*, 7–24. [\[CrossRef\]](#)
13. Walker, S. Tree exhaustion. *Stud. Art Educ.* **2014**, *56*, 355–358. [\[CrossRef\]](#)
14. Kinchin, I.M.; Winstone, N.E.; Medland, E. Considering the concept of reciprocity in student learning from a modified Bernsteinian perspective. *Stud. High. Educ.* **2020**. [\[CrossRef\]](#)
15. Tillmanns, T.; Holland, C.; Lorenzi, F.; McDough, P. Interplay of rhizome and education for sustainable development. *J. Teach. Educ. Sust.* **2014**, *16*, 5–17. [\[CrossRef\]](#)
16. Strom, K.J. “That’s not very Deleuzian”: Thoughts on interrupting the exclusionary nature of “High Theory”. *Educ. Philos. Theory* **2018**, *50*, 10413. [\[CrossRef\]](#)
17. Guttorm, H.; Hohti, R.; Paakkari, A. ‘Do the Next Thing’: An Interview with Elizabeth Adams St. Pierre on Post-Qualitative Methodology. *Reconcept. Educ. Res. Meth.* **2015**, *6*, 15–22. [\[CrossRef\]](#)
18. Rorty, R. *Consequences of Pragmatism, Essays: 1972–1980*; University of Minnesota Press: Minneapolis, MN, USA, 1982.
19. Novak, J.D. Concept mapping: A useful tool for science education. *J. Res. Sci. Teach.* **1990**, *27*, 937–949. [\[CrossRef\]](#)
20. Richmond, S.S.; Defranco, J.F.; Jablockow, K. A set of guidelines for the consistent assessment of concept maps. *Int. J. Eng. Educ.* **2014**, *30*, 1072–1082.
21. Watson, M.K.; Pelkey, J.; Noyes, C.R.; Rodgers, M.O. Assessing conceptual knowledge using three concept map scoring methods. *J. Eng. Educ.* **2016**, *105*, 118–146. [\[CrossRef\]](#)
22. Won, M.; Krabbe, H.; Ley, S.L.; Treagust, D.F.; Fischer, H.E. Science teachers’ use of a concept map marking guide as a formative assessment tool for the concept of energy. *Educ. Assess.* **2017**, *22*, 95–110. [\[CrossRef\]](#)
23. Novak, J.D.; Gowin, D.B. *Learning How to Learn*; Cambridge University Press: Cambridge, UK, 1984.
24. White, R.; Gunstone, R. *Probing Understanding*; The Falmer Press: London, UK, 1992.
25. Safayeni, F.; Derbentseva, N.; Cañas, A.J. A theoretical note on concepts and the need for cyclic concept maps. *J. Res. Sci. Teach.* **2005**, *42*, 741–766. [\[CrossRef\]](#)
26. Kinchin, I.M.; Hay, D.B.; Adams, A. How a qualitative approach to concept map analysis can be used to aid learning by illustrating patterns of conceptual development. *Educ. Res.* **2000**, *42*, 43–57. [\[CrossRef\]](#)
27. Kinchin, I.M. A ‘species identification’ approach to concept mapping in the classroom. *J. Biol. Educ.* **2020**, *54*, 108–114. [\[CrossRef\]](#)
28. Kinchin, I.M. Concept mapping and the fundamental problem of moving between knowledge structures. *J. Educ. Teach. Train.* **2013**, *4*, 96–106.
29. Kinchin, I.M.; Cabot, L.B. Reconsidering the dimensions of expertise: From linear stages towards dual processing. *Lond. Rev. Educ.* **2010**, *8*, 153–166. [\[CrossRef\]](#)
30. Rajchman, J. *The Deleuze Connections*; MIT Press: Cambridge, UK, 2001.
31. Kinchin, I.M. *Visualising Powerful Knowledge to Develop the Expert Student: A Knowledge Structures Perspective on Teaching and Learning at University*; Sense: Rotterdam, The Netherlands, 2016.

32. Braidotti, R. A theoretical framework for the critical posthumanities. *Theory Cult. Soc.* **2018**, *36*, 31–61. [[CrossRef](#)]
33. Honan, E. Writing a rhizome: An (im)plausible methodology. *Int. J. Qual. Stud. Educ.* **2007**, *20*, 531–546. [[CrossRef](#)]
34. Strom, K.J.; Martin, A.D. *Becoming-Teacher: A Rhizomatic Look at First-Year Teaching*; Sense: Rotterdam, The Netherlands, 2017.
35. DeLanda, M. *Assemblage Theory*; Edinburgh University Press: Edinburgh, UK, 2016.
36. May, T. When is a Deleuzian becoming? *Cont. Philos. Rev.* **2003**, *36*, 139–153. [[CrossRef](#)]
37. Martin, A.D.; Kamberelis, G. Mapping not tracing: Qualitative educational research with political teeth. *Int. J. Qual. Stud. Educ.* **2013**, *26*, 668–679. [[CrossRef](#)]
38. Wilson, J.; Mandich, A.; Magalhães, L. Concept mapping: A dynamic, individualized and qualitative method for eliciting meaning. *Qual. Health Res.* **2016**, *26*, 1151–1161. [[CrossRef](#)]
39. Lenz Taguchi, H. Deleuzo-Guattarian rhizomatics: Mapping the desiring forces and connections between educational practices and the neurosciences. In *Posthuman Research Practices in Education*; Taylor, C.A., Hughes, C., Eds.; Palgrave Macmillan: New York, NY, USA, 2016; pp. 37–57.
40. Karpicke, J.D.; Blunt, J.R. Retrieval practice produces more learning than elaborative studying with concept mapping. *Science* **2011**, *331*, 772–775. [[CrossRef](#)]
41. Lechuga, M.T.; Ortega-Tudela, J.M.; Gómez-Ariza, C.J. Further evidence that concept mapping is not better than repeated retrieval as a tool for learning from texts. *Learn. Inst.* **2015**, *40*, 61–68. [[CrossRef](#)]
42. Mintzes, J.J.; Cañas, A.; Coffey, J.; Gorman, J.; Gurley, L.; Hoffman, R.; McGuire, S.Y.; Miller, N.; Moon, B.; Trifone, J.; et al. Comment on “Retrieval practice produces more learning than elaborative studying with concept mapping”. *Science* **2011**, *334*, 453. [[CrossRef](#)]
43. Karpicke, J.D.; Blunt, J.R. Responses to comment on “Retrieval practice produces more learning than elaborative studying with concept mapping”. *Science* **2011**, *334*, 453. [[CrossRef](#)]
44. Kinchin, I.M. Enhancing the Quality of Concept Mapping Interventions in Undergraduate Science. In *Active Learning in College Science: The Case for Evidence-Based Practice*; Mintzes, J.J., Walter, E.M., Eds.; Springer Nature: Berlin, Germany, 2020; pp. 107–119.
45. Hanley, P.; Chambers, B.; Haslam, J. Reassessing RCTs as the ‘gold standard’: Synergy not separation in evaluation design. *Int. J. Res. Meth. Educ.* **2016**, *39*, 287–298. [[CrossRef](#)]
46. Cañas, A.J.; Reiska, P.; Möllits, A. Developing Higher Order Thinking Skills with Concept Mapping: A Case of Pedagogic Frailty. *Knowl. Manag. E-Learn.* **2017**, *9*, 348–365.
47. Joseph, C.; Conradson, D.; Wikmar, L.N.; Rowe, M. Structured feedback on students’ concept maps: The proverbial path to learning? *BMC Med. Educ.* **2017**, *17*, 90. [[CrossRef](#)] [[PubMed](#)]
48. Blunt, J.R.; Karpicke, J.D. Learning with retrieval-based concept mapping. *J. Educ. Psychol.* **2014**, *106*, 849–858. [[CrossRef](#)]
49. Bazzul, J.; Kayumova, S. Toward a social ontology for science education: Introducing Deleuze and Guattari’s assemblages. *Educ. Philos. Theory* **2016**, *48*, 284–299.
50. Morse, D.; Jutras, F. Implementing concept-based learning in a large undergraduate classroom. *CBE Life Sci. Educ.* **2008**, *7*, 243–253. [[CrossRef](#)] [[PubMed](#)]
51. Evans, C. Making sense of assessment feedback in higher education. *Rev. Educ. Res.* **2013**, *83*, 70–120. [[CrossRef](#)]
52. Mooney Simmie, G.; Moles, J.; O’Grady, E. Good teaching as a messy narrative of change within a policy ensemble of networks, superstructures and flows. *Crit. Stud. Educ.* **2019**, *60*, 55–72. [[CrossRef](#)]
53. Harris, D. Rhizomatic education and Deleuzian theory. *Open Learn. J. Open Distance E-Learn.* **2016**, *31*, 219–232. [[CrossRef](#)]
54. Bell, A. The vascular pattern of a rhizomatous ginger (*Alpinia speciosa* L. Zingiberaceae). 1. The aerial axis and its development. *Ann. Bot.* **1980**, *46*, 203–212. [[CrossRef](#)]
55. Bell, A. The vascular pattern of a rhizomatous ginger (*Alpinia speciosa* L. Zingiberaceae). 2. The rhizome. *Ann. Bot.* **1980**, *46*, 213–220. [[CrossRef](#)]
56. Massey, D. *For Space*; Sage: London, UK, 2005.
57. Koro-Ljungberg, M. *Reconceptualising Qualitative Research: Methodologies Without Methodology*; Sage: London, UK, 2016.

58. Deleuze, G.; Bacon, F. *Francis Bacon: The Logic of Sensation*; University of Minnesota Press: Minneapolis, MN, USA, 2003.
59. Bell, A. The hexagonal branching pattern of rhizomes of *Alpinia speciosa* L. (Zingiberaceae). *Ann. Bot.* **1979**, *43*, 209–223. [[CrossRef](#)]
60. Bell, A.D.; Tomlinson, P.B. Adaptive architecture in rhizomatous plants. *Bot. J. Linn. Soc.* **1980**, *80*, 125–160. [[CrossRef](#)]
61. Guerin, C. Rhizomatic research cultures, writing groups and academic researcher identities. *Int. J. Dr. Stud.* **2013**, *8*, 137–150. [[CrossRef](#)]
62. Peñuela-Epalza, M.; De la Hoz, K. Incorporation and evaluation of serial concept maps for vertical integration and clinical reasoning in case-based learning tutorials: Perspectives of students beginning clinical medicine. *Med. Teach.* **2018**. [[CrossRef](#)]
63. Grigoriou, Z. Commencing the Rhizome: Towards a minor philosophy of education. *Educ. Philos. Theory* **2004**, *36*, 233–251. [[CrossRef](#)]
64. Lee, Y.-J. Thriving in-between the cracks: Deleuze and guerilla science teaching in Singapore. *Cult. Stud. Sci. Educ.* **2008**, *3*, 917–935. [[CrossRef](#)]



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